Center Innovation Fund: JSC CIF

Modeling limbless locomotion using ADAMS software

Completed Technology Project (2012 - 2012)

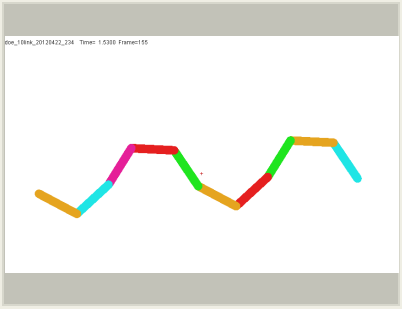
Project Introduction

Until now, the methods used by probes or humans for locomotion on planetary surfaces have typically been restricted to variations of wheeled motion. As human endeavors on other planetary bodies expand, it would be advantageous to consider other, lesser studied methods of locomotion seen in nature such as the limbless locomotion of snakes, burrowing and flying. This project studies the feasibility of using limbless locomotion for transportation over surfaces and possibly for other applications.

Limbless locomotion has the potential of meeting transportation requirements, particularly in challenging environments. Snakes can traverse a variety of surfaces including hard ground, sandy or rocky terrain and can in addition, climb trees and swim through water. Limbless locomotion offers several advantages over other more conventional forms of locomotion that have been used for space exploration. With the center of gravity close to the ground, serpentine robots would be very stable – for wheeled or legged robots on the other hand stability would be a constant concern particularly over uneven terrain. Serpentine robots offer the promise of being able to traverse terrain like soft soils, rocky terrain and narrow passageways that could defeat wheeled or legged robots. As seen in snakes, limbless locomotion isn't restricted to a single gait but, in fact, appears in several forms each offering advantages in terms of speed, stability, energy consumption and suitability for a particular terrain. The entire mechanism for locomotion is contained within the body of the robot. This allows better sealing between the mechanism internals and the environment which can be a great advantage in hostile environments. In addition limbless locomotion offer advantages in terms of mechanism redundancy, small frontal area and large surface area in relation to the volume. This can potentially be used to advantage: for example to mount solar cells and scientific instruments. The flexibility of the mechanism offers other possible uses as well: snake like mechanisms can wrap around rocks or burrow into loose sandy soil/rock aggregate to anchor spacecraft to asteroids. From the brief literature survey conducted for this proposal, it appears that limbless locomotion is a still developing field that offers a whole new world of potential applications. The ADAMS multibody dynamics software package from MSC software is an industry standard tool widely used for analysis of mechanical systems.

Anticipated Benefits

Until now, the methods used by probes or humans for locomotion on planetary surfaces have typically been restricted to variations of wheeled motion. As human endeavors on other planetary bodies expand, it would be advantageous to consider other, lesser studied methods of locomotion seen in nature such as the limbless locomotion of snakes, burrowing and flying. This proposal studies the feasibility of using limbless locomotion for exploration and transportation over surfaces and possibly for other applications.



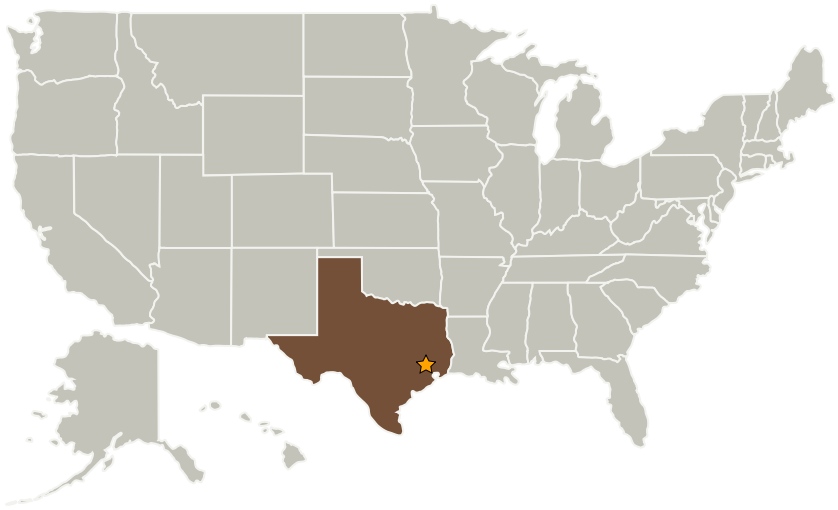
Project Image Modeling limbless locomotion using ADAMS software

Table of Contents

Modeling limbless locomotion using ADAMS software

Completed Technology Project (2012 - 2012)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Jacobs Engineering Group, Inc.	Supporting Organization	Industry	Dallas, Texas

Primary U.S. Work Locations
Texas

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Center Innovation Fund: JSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Carlos H Westhelle

Project Manager:

Prashant S Rao

Principal Investigator:

Prashant S Rao

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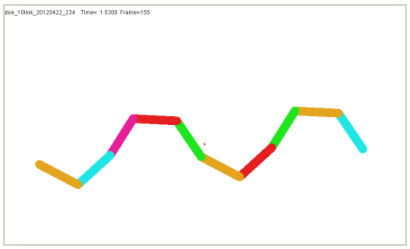
Images



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Project Image Modeling limbless locomotion using ADAMS software
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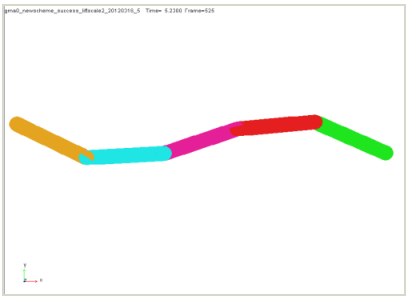

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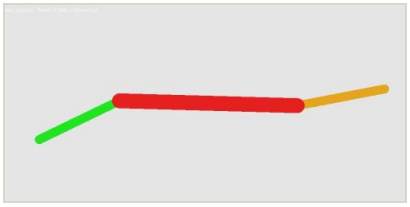

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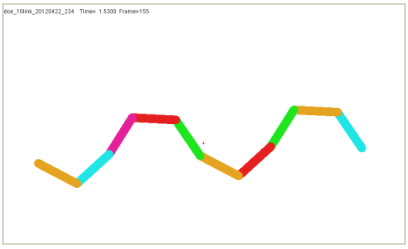

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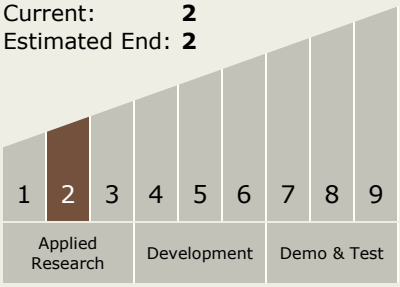
Project Image Modeling limbless locomotion using ADAMS software
(https://techport.nasa.gov/image/2347)

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **2**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.2 Mobility
    - TX04.2.4 Surface Mobility